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ABSTRACT

This document describes the review, analysis, and decision-making process that Trinity University, Texas, went through to develop the three-part computer network that they use to gather and analyze EEG (electroencephalography) and EKG (electrocardiogram) data. The data are gathered in the laboratory on a PDP-1124, an analog minicomputer. Once gathered, they are converted from analog-to-digital (A/D) and sent by the PDP to an IBM 370 3031. The data are then submitted to a fast fourier analysis (FFT) on the IBM computer. Once the FFT are completed, the data are accessed by an IBM PC-XT which is equipped with an IRMA network system. The PC is used in its emulation mode to access the data in the mainframe where either SPSS (Statistical Package for the Social Sciences) or SAS (Statistical Analysis System) is then used to do the initial statistical analyses. When necessary, subsets of the data are transferred to the PC where other computer programs are used to analyze the data. In many instances, they are returned to the mainframe from the PC where they are submitted to multivariate statistical analysis. Finally, all of the data are stored on floppy disks which are prepared on the PC. (Author/THC)

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The Use of Computer Networks in Data Gathering and Data Analysis

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The Use of Computer Networks in Data Gathering and Data Analysis

ABSTRACT

In our research, the data are gathered in the laboratory on a PDP-1124 minicomputer. Once the data are gathered, they are analog-to-digital (A/D) converted and sent by the PDP to an IBM 370 3031. The data are submitted to a fast fourier analysis (FFT) on the IBM computer. Once the FFT are completed, the data are accessed by and IBM PC-XT which is equiped with an IRMA system. The PC is used in its emulation mode to access the data in the mainframe. In the mainframe, SPSS or SAS is used to do the initial statistical analyses. When necessary, subsets of the data are transferred to the PC where other computer programs are used to analyze the data. In many instances, they are returned to the mainframe from the PC where they are submitted to multivariate statistical analysis. Finally, all of the data are stored on floppy disks which are prepared on the PC.

The Use of Computer Networks in Data Gathering and Data Analysis

Introduction

The gathering, handling, and analysis of EEG and EKG data have always been difficult. The sensitivity of the instruments used, the rate at which the data are gathered, the transformation of the data needed prior to statistical analysis, and the amount of data gathered from each subject make the entire experimental process one which is filled with tasks that must be carried out with great care. Each step of the experiment must be conducted with care for the results to be valid. We now have the power and sophistication of computers to assist us in the gathering and managing of our complex data

The gathering and handling of EEG and EKG data are a series of complex tasks. The initial gathering and storage of the data require the use of a computer which can work with analog data. Also, a computer that can electronically control the delivery of a stimulus as a part of the experiment is frequently needed. Once the data are gathered, they must be transformed from their original analog form to a digital form. The performance characteristics of the computer used to transform the data from one form to another are typically different from those of the computer which is used to control the experiments and to gather the data. Finally the data must be reviewed, edited, and

statistically analyzed. Performing these final tasks usually requires the use of a third type of computer. This third type of computer is usually a large, powerful one which is designed to do mathematical calculations. To be able to efficiently use two or three different computers in conducting a single experiment requires that the the computers be interfaced or networked together. Through networking or interfacing, the data can be passed from one computer to another without having to be reentered. This article describes the review, analysis, and decision making process that we went through to develop the computer network which we use to gather and analyze EEG and EKG data.

Computer Network

We have developed a network of three computers which we use to conduct our research. Figure 1 contains a graphic description of the network. The data are gathered and the experiments are controlled by a PDP-1124 computer which is located directly in the neuropsychology laboratory. Basically, the PDP-1124 is configured as a process control computer. Using this computer in conjunction with a Vetter analog tape recorder we can gather up to seven channels of data at a sampling rate of 256 data points per second. The PDP computer and Vetter tape recorder can be used to gather these data while, at the same time, the computer is

controlling the delivery of stimuli to subjects.

The data that we gather is in an analog form. Prior to analyzing the data, we transform the analog data to digital data (A/D). The A/D conversion is performed on the PDP computer at a rate of 256 points per second per chanel. We have a dedicated coaxial line between our PDP computer and the principal mainframe computer for our campus. This mainframe computer is an IBM 3031 with 12 megabytes of virtual memory. We use a program called KERMIT to send the digitized data from the PDP computer to the IBM computer. The process of identifying, acquiring, and using KERMIT is described elsewhere (Holcomb and Eddy, 1984). Once the data are sent to the mainframe, they are stored on tape and then submitted to a computer program which performs a fast fourier transform (FFT) on them. To perform the FFT, we use either a program which was developed by Benignus (19) or the Statistical Analysis System (19). Either of these programs can be used through the use of an IBM 3278 terminal attached to the mainframe. These terminals are available from many locations on our campus. The editor and control functions of the Conversational Monotoring System (CMS) are used to operate these programs.

The principal advantage of using the mainframe to perform the FFT is the speed with which it can perform the task. A great deal of data are generated when we gather multiple channels of data at a 256 data points per second rate for as much as 20 seconds. It has been our experience that a large, powerful

mainframe is required to perform this mathematical task. Usually we submit the data to the FFT on the IBM computer at non-prime times.

The output from the FFT program are the data which are used in the statistical analyses. Prior to the time that the data are submitted to a statistical analysis, they must be reviewed and, in some instances, edited. It has been our experience that because of the loads on the IBM mainframe and the availability of terminals during the working day, it is best to take the data from the IBM mainframe to a microcomputer for editing and initial analyses. To do this, we pass the data from the IBM mainframe to an IBM PC-XT which has been networked with the IBM mainframe.

Selecting an Intelligent Workstation

We went through a number of different networking options prior to selecting the IBM PC-XT. Our first attempt was to use a dumb terminal with a 1200 baud modem. This configuration gave us access to the mainframe to perform our data analysis tasks, but due to the load on the mainframe, its use to us during prime-time hours was often limited. There were several other limitations to the use of this configuration. When our IBM mainframe is accessed through a telephone line the user is limited to the use of the EDIT editor and cannot use the XEDIT editor. For those who are

not familiar with the difference in these two editors, the XEDIT editor allows full screen editing and the EDIT editor allows only one-line-at-a-time editing. The use of EDIT is more cumbersome and is slower than XEDIT. Also, a 1200 Baud transmission rate seems to be an acceptable rate at first, but after a very short time this rate becomes very slow, and the terminal appears to lack responsiveness. Finally, even with a hard disk attached to the dumb terminal, the process of storing and retrieving data is difficult and cumbersome.

Our second attempt at networking was to use a microcomputer in conjunction with a modem as an intelligent workstation. This configuration gave us a little more flexibility but it still proved to be impractical. The speed with which we could work was about the same as with the dumb terminal and we still could use only the EDIT editor and not the XEDIT editor. The fact that this was an intelligent workstation did give us some added flexibility over the dumb terminal in that the microprocessor could be used as a stand-alone unit when not connected to the mainframe. Passing files between the microprocessor and the mainframe was a complex task and one which was time consuming. The data transfer rates between the two computers was very limited for the size of the data files that we use in our analyses.

In our third and final attempt at networking, we chose to acquire the IBM PC-XT. This computer is equipped with 512 K

bytes of core and has a 10-megabyte hard disk. In addition, we purchased an IRMA communications card and the accompanying software programs to use in our research. The combination of this PC-XT, the hard disk, the IRMA card, and the IRMA software seems to satisfy our research needs very well. The IRMA card is installed inside of the PC-XT and the software is installed both on the hard disk and in one of our CMS machines on the IBM mainframe. The IRMA card is hard-wired directly into the mainframe. The IBM PC-XT is a very powerful machine in itself and is capable of performing a great deal of work. We keep several statistical packages, a graphics package, a database manager, and a word processing package resident on the disk for immediate use at all times. We also have a printer, a plotter, a color graphics monitor, and a monochrome monitor as peripherals on the PC-XT. These peripheral devices serve to make our research efforts more efficient and we also enjoy the independence from the computer center that they give us.

The use of the PC-XT as a terminal is very simple. Once the computer is booted, it automatically seeks out and connects itself to the mainframe. To use the mainframe, the user simply signs on and gives the necessary passwords and account numbers. The transfer rate between the PC-XT and the mainframe is 9600 Baud. Because of the way that the PC-XT is connected to the mainframe it is possible to use the XEDIT editor. One of the powerful assets of the use of the IRMA communications system is that we can use the PC-XT as a microprocessor and a terminal to

the mainframe simultaneously. That is, it is possible to boot the PC-XT, sign on to the mainframe and submit several jobs to be processed, and while they are processing, switch back to the PC-XT and use it as a microprocessor. Switching back and forth between systems is done by pressing two keys simultaneously. Transferring files between the mainframe and the PC-XT is a menu-driven process. The files are transferred directly between a CMS machine and the PC-XT. The process is started by executing a program on the PC-XT which brings a menu on the screen. Simple non-programming responses to the menu are required to transfer programs or data in either direction between the two computers. Large data sets can be transferred between the two computers in reasonable amounts of time. We find that it is easier to store large data sets on floppy disks with the PC-XT and the IRMA system than it is to store them on tapes at the computer center.

In 1983 the IBM Corporation announced the availability of a 3278/79 emulation system. This system is presently available for use with the IBM PC and the IBM PC-XT. This IBM system also requires the installation of a board inside the computer and the installation of software in both the mainframe and the microcomputer. The function, use, and operation of the IBM system are almost identical to the IRMA system. Both of the systems cost approximately $1100.00.

We have been successful in developing a method which permits us to use the same datasets with programs on both the PC-XT and

the mainframe. We access the data on the mainframe with either SAS or SPSS. Both of these programs have options which permit the user to generate data files within the mainframe. We begin our work on the mainframe by developing a data set which we want to analyze. We use the standard data set generation techniques to insert the common delimiters and end-of-file marks which are required by the programs on the PC-XT. Once the file has been generated, we transfer it to the PC-XT, where we read it into the directory of our Total Information Management System (TIM), which is a data base management program. We then use the utility programs within TIM to transfer the data to the directory containing the statistical program or the directory containing the graphics program. The entire process can be reversed when data are transferred from the PC-XT to the mainframe. When the data are in the mainframe, they are in an EBCDIC form, and when they are in the PC-XT, they are in an ASCII form. When the IRMA system is used to transfer the data from one computer to another, the data are automatically transformed from one form to the other.

At present, we feel very comfortable with our ability to use our three computers to conduct our research. We use each of the three computers to perform the tasks that it does best, and we have no problems in passing the data from one computer to the other. We believe that ours is a very efficient and effective research working environment.

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Figure 1
Computer Network